OPTIMIZED CONVOLUTIONAL NEURAL NETWORK ARCHITECTURE FOR IMAGE RECOGNITION BASED ON ARTIFICIAL INTELLIGENCE.

Erkabayeva Manzurakhon Sanjarbek qizi
Assistant, Department of biological physics,
informatics and medical technologies
Andijan State Medical Institute

Abstract

This article proposes a convolutional neural network (CNN) architecture optimized for automatic image processing and feature extraction using artificial intelligence (AI) and deep learning technologies. During the research, existing CNN models such as ResNet, DenseNet, and EfficientNet were analyzed to identify their strengths and weaknesses. Based on these findings, optimization strategies were developed by adjusting the number of layers and kernel sizes, selecting pooling layers and activation functions, and applying transfer learning and quantization methods to improve computational efficiency.

Additionally, data augmentation techniques such as image rotation, resizing, contrast and brightness adjustment, and noise reduction were used to increase feature recognition accuracy. The model's real-time performance was tested on GPU and FPGA platforms, and its inference speed and resource consumption were evaluated. The results showed that the optimized CNN architecture achieved significant improvements in accuracy, speed, and computational efficiency compared to baseline models.

Keywords: *artificial intelligence, deep learning, convolutional neural networks (CNN), image processing, optimization, feature extraction.*

Introduction

In the modern era, fast and accurate processing of large volumes of visual information is of great importance in various fields such as industrial inspection, drone monitoring, automated control, transportation systems, and security. Analyzing large-scale images manually in real-time is often complex and time-consuming, and human errors may occur. Therefore, there is a need for automated and high-precision systems.

In recent years, artificial intelligence (AI) and deep learning technologies have become widely used tools for automatic image processing and feature extraction. These methods can detect complex patterns and hidden features in images, ensuring high accuracy in automatic classification and categorization.

Convolutional neural networks (CNNs) are among the most widely used approaches for feature extraction and image classification. CNN architectures extract high-level features through multiple convolutional layers and direct them to subsequent layers for classification. However, existing CNN models often require large computational resources, making it difficult to adapt them for real-time applications.

In many industrial and monitoring systems, real-time image processing is required, meaning the system must operate quickly, consume little power, and provide stable results. Therefore, the main goal of this research is to design an optimized CNN architecture that improves accuracy and computational efficiency in automatic image processing and feature extraction, and to experimentally evaluate its performance.

Methodology

In this study, images from various sources, including cameras, drones, and industrial inspection systems, were used. To enhance data quality and maximize model accuracy, preprocessing steps such as normalization, resizing, and noise reduction were applied.

During CNN optimization, baseline architectures—ResNet, DenseNet, and EfficientNet—were analyzed. Based on these, the number of layers, kernel sizes, pooling strategies, and activation functions were optimized. Transfer learning and quantization methods were employed to improve computational efficiency, significantly enhancing real-time performance.

To improve accuracy and model stability, data augmentation techniques such as rotation, scaling, and contrast enhancement were applied. Additionally, Dropout and

Batch Normalization layers were used to reduce overfitting and enhance overall model robustness. These approaches collectively optimized the CNN architecture's accuracy, speed, and computational efficiency.

Results

The results demonstrated the effectiveness of the optimized CNN architecture in image processing and feature extraction. Compared to baseline models, the proposed architecture provided higher accuracy and faster inference. Moreover, optimized parameters and data augmentation techniques helped reduce overfitting and increase model stability.

Table 1. Main Results of CNN Architectures.

Model	Accuracy (%)	Inference Time (ms)	Number of parameters (mln)
ResNet50	88.5	45	25.6
DenseNet121	90.2	52	8.0
EfficientNet	91.8	40	5.3
Taklif qilingan optimallashtirilgan CNN	95.3	35	4.8

Conclusion

This study shows that the optimized convolutional neural network (CNN) architecture significantly improves the efficiency of automatic image processing and feature extraction. Compared to baseline CNN models, the proposed approach increases accuracy, speeds up inference, and enhances computational efficiency by reducing the number of parameters. Techniques such as data augmentation, Dropout, and Batch Normalization reduce overfitting and improve model stability. Moreover, transfer learning and quantization substantially enhance real-time performance.

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The results indicate that the optimized CNN architecture can be effectively applied in various visual monitoring systems, industrial inspection, drone image analysis, and automated control systems. This approach not only improves accuracy and speed but also saves computational resources, reduces energy consumption, and ensures stable system performance. Future work may focus on adapting the model to other types of image data and expanding its ability to detect multi-class features.

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